

Productivity in Ecosystems

Objective: Determine primary & secondary productivity in ecosystems

Introduction: Ecologists study life in a variety of ecosystems, including aquatic & terrestrial. The health of any ecosystem can be determined by factors such as energy flow and food availability. From your experience with the population lab, which trophic level of a food chain/web is the most vital and why?

Gross Primary Productivity (GPP) is represented by the energy of producers while Gross Secondary Productivity (GSP) is represented by the herbivore energy. Higher order consumers would follow a similar pattern. Gross numbers are not accurate for determining energy flow because **not all energy will be transferred.**

Net Primary Production (NPP) = biomass available for herbivores to consume

Net Secondary Production (NSP) = biomass available for higher consumers to consume

NPP can be determined by several methods.

1. Light-Dark Bottle Method for *Aquatic Samples*

Several samples of water (containing aquatic producers) are sampled for amount of dissolved oxygen (**DO**) produced which indirectly gives a measure of photosynthesis output.

A. 1 bottle filled with sample water is used to determine **INITIAL Oxygen** in water.

B. Bottles contain photosynthetic microorganisms, exposed to sunlight to allow photosynthesis to occur. After set time period, amount of oxygen will be measured.

C. 1 bottle filled with water sample is covered to block sunlight, to determine the **RESPIRATION demands**. The initial bottle MINUS the Respiration bottle gives the respiration demands.

D. Other bottles are used to determine how much oxygen is produced for a given amount of sunlight.

Sample Data:

A student hypothesized that the higher percentage of light received by aquatic producers, the greater the productivity would be. The initial oxygen reading for this water was 4 mg O₂/l.

Initial Bottle Oxygen = 4 mg O₂/l Dark (respiration) Bottle Oxygen = 1 mg O₂/l

What is the respiration rate? _____ mg O₂/l

Complete the data table

Sample column MINUS Dark value = GPP for that sample

0 % light: $1 - 1 = 0$ mg O₂/l

Sample column MINUS Initial Bottle = NPP for that sample

0 % light: $1 - 4 = -3$ mg O₂/l

% Light	DO in sample	GPP	NPP
0	1 mg O ₂ /l	0	-3
2	2 mg O ₂ /l		
10	3 mg O ₂ /l		
25	5 mg O ₂ /l		
65	10 mg O ₂ /l		
100	14 mg O ₂ /l		

2. Biomass Method for Terrestrial NPP & GPP

Massing organisms and calculating a change over time is the other way to determine productivity.

There is one MAJOR flaw to this method. Organism biomass needs to consider only biomass, but what other substance is found in all living things that accounts for a lot of mass?

One of two things can be done to account for this: DRY the organism or estimate percentage of water. Both are not favorable due to either having to kill the organism or errors in estimation. Nonetheless, both are used in ecological studies.

Practice Problem:

You wish to study the energy dynamics between grass & grasshoppers. Given Information:

Dry Grass Energy value = 4.35 kcal/g

Dry Grasshopper Energy value = 5.50 kcal/g

Assume that the grasshoppers are about 30% water and the grass is 40% water.

Data:

Organism	week 1 <u>wet</u> mass	week 2 <u>wet</u> mass
Grass	6.92g	8.57g
Grasshopper	.8754g	.9635g

1. Determine the NPP for the grass & the NSP for the grasshopper between week 1 & week 2 (measured in kcal/week)

2. What additional factors would you need to include if you wanted to determine the **GROSS** productivity for each organism? (See notes)